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I HEREBY CERTIFY that annexed hereto is a true copy of documents filed in connection with the following patent application:

| | |
|---|---|
| Application No. | S2000/0558 |
| Date of Filing | 10 July 2000 |
| Applicant | RICHMOUNT COMPUTERS LIMITED, an Irish Company of Maple House, South County Business Park, Leopardstown, Dublin 18, Ireland. |

Dated this 16 day of March 2001.

An officer authorised by the
Controller of Patents, Designs and Trademarks.

S000558

FORM NO. 1

# REQUEST FOR THE GRANT OF A PATENT
## PATENTS ACT, 1992

The Applicant named herein hereby request

_ the grant of a patent under Part II of the Act

X the grant of a short-term patent under Part III of the Act

on the basis of the information furnished hereunder.

1. **APPLICANT**

| | |
|---|---|
| **Name** | **RICHMOUNT COMPUTERS LIMITED** |
| **Address** | **Maple House, South County Business Park, Leopardstown, Dublin 18, Ireland.** |
| **Description/Nationality** | **An Irish Company** |

2. **TITLE OF INVENTION**

"Power Supply Information Protocol"

3. **DECLARATION OF PRIORITY ON BASIS OF PREVIOUSLY FILED APPLICATION FOR SAME INVENTION (SECTIONS 25 & 26)**

| Previous filing date | Country in or for which filed | Filing No. |
|---|---|---|

4. **IDENTIFICATION OF INVENTOR(S)**
**Name(s) of person(s) believed by Applicant(s) to be the inventor(s)**
1.

**Address**
1.

5. **STATEMENT OF RIGHT TO BE GRANTED A PATENT (SECTION 17(2)(B))**

By virtue of

**Contd./...**

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6. **ITEMS ACCOMPANYING THIS REQUEST - TICK AS APPROPRIATE**

(i) X prescribed filing fee EUR 63.49 (IR£50.00)

(ii) _ specification containing a description and claims

X specification containing a description only

X Drawings referred to in description or claims

(iii) _ An abstract

(iv) _ Copy of previous application(s) whose priority is claimed

(v) _ Translation of previous application whose priority is claimed

(vi) _ Authorisation of Agent (this may be given at 8 below if this Request is signed by the Applicant(s))

7. **DIVISIONAL APPLICATION**

The following information is applicable to the present application which is made under Section 24

Earlier Application No:
Filing Date:

8. **AGENT**

The following is authorised to act as agent in all proceedings connected with the obtaining of a Patent to which this request relates and in relation to any patent granted -

| **Name** | **Address** |
| --- | --- |
| F. R. KELLY & CO. | at their address as recorded for the time being in the Register of Patent Agents |

9. **ADDRESS FOR SERVICE (IF DIFFERENT FROM THAT AT 8)**

RICHMOUNT COMPUTERS LIMITED
F. R. KELLY & CO.

By: ________________
EXECUTIVE

**Date: July 10, 2000**

10 JUL 2000

## 1 Introduction

... As part of the specification there is a requirement to have each power supply gather its own environment information and report it to the Environment Monitoring System, referred to as VIXEN in this document using a 2 wire serial bus. The name of this project is PICO, the name was generated based on 'P' for power supply and the microcontroller should be small and compact, hence PICO = $n*10^{-12}$, e.g. picofarads (pF) for capacitors.

## 2 Scope

This document is a functional specification, dealing with all the requirements to be addressed in the first release of PICO. These issues will be discussed and ideas put forward to allow engineers to agree the design and implementation of specific features.

## 3 Reference Documents


| | | |
|---|---|---|
| /1/ | Eurologic | Firmware Group Coding Guidelines<br>http://intranet.eurologic.com/rd/firmware/general/code_st/ |
| /2/ | Eurologic | Hurricane Power Supply Engineering Specification (PICO)<br>(Version 0.4, Date 21/09/1999) |
| /3/ | Eurologic | Hurricane-9 Fibre Channel Storage Enclosure Engineering Specification.<br>(Version 0.2, Date 11/07/1999) |
| /4/ | NEC | UPD789177Y 8-bit single chip microcontroller Product Information<br>(Doc. No. U13216EJ1V0PM00 Revision March 1998)<br>http://www.necel.com/ |
| /5/ | NEC | UPD789177Y subseries 8-bit single chip microcontroller User's Manual.<br>(Doc. No. U13349EJ1V0UM00 Revision June 1998)<br>http://www.necel.com/ |




## 4 Hardware Overview

Both physical space and cost limit the hardware for this project. The microcontroller that was chosen is from the NEC K0S family (uPD78F9177YGB-8ES). The following discussion does refer to the specific device and to the requirements that the firmware will be expected to meet.

### 4.1 PICO Hardware Block Diagram

The PICO board will be as shown in Figure 4.1 below. The microcontroller supports 8 analog to digital converters (ADC) 6 of which will be used, a 2 wire serial bus which will be used to communicate to VIXEN, 11 digital inputs for general purpose i/o (GPIO) (of which one has to be an interrupt) and one LED output. The temperature sensor will be connected to the 2 wire serial bus, but it will not be under control of the PICO microcontroller.

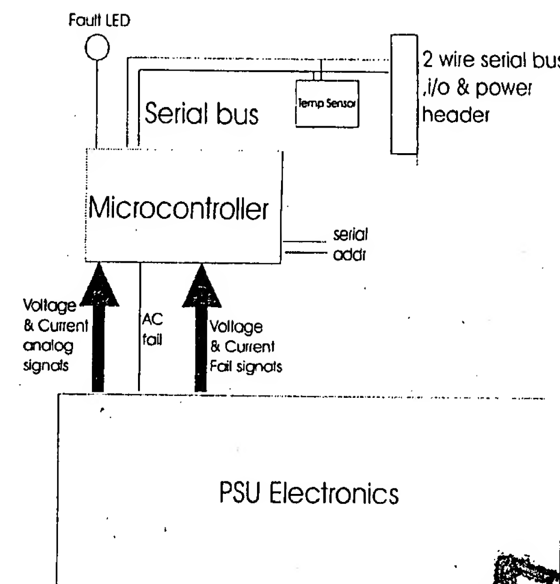


Figure 4.1

### 4.2 Analog to Digital Converter (ADC)

The ADC voltage range will be between Gnd and Vcc of the microcontroller. For PICO the analog voltages will be called AGnd and AVcc.

Gnd = 0V = AGND and Vcc = 5V(+/-0.3V) = AVcc

The ADC will have an 8-bit resolution, where 00 hex will be 0V and FF hex will be the maximum voltage that can be measure on that voltage rail.

### 4.2.1 Voltage Measurements

PICO will be required to monitor the 3.3V, 5V and 12V power rails in the PSU. The 5V and 12V rails will be scaled in order to have the voltages in the ADC voltage range.

For Hurricane, the maximum voltage that can be measured on the 3.3V rail is 5V so the bit resolution will be 19.5mV. The 5V and 12V rails will need to be scaled down to a range between AGND (Gnd) and AVCC (Vcc +/- 0.3V) in order to measure the levels. The ADC will be capable of measuring up to 6.5V maximum on the 5V line, so the bit resolution will be 24.5mV. The ADC will be capable of measuring up to 15V maximum on the 12V line, so the bit resolution will be 58.6mV.

The voltage levels per bit are shown on the table below.

| Bit No. / Voltage Level | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| 3.3v | 2.5 | 1.25 | 0.625 | 0.3125 | 0.156 | 0.078 | 0.039 | 0.0195 |
| 5v | 3.136 | 1.568 | 0.784 | 0.392 | 0.196 | 0.098 | 0.049 | 0.0245 |
| 12v | 7.5008 | 3.7504 | 1.8752 | 0.9376 | 0.4688 | 0.2344 | 0.1172 | 0.0586 |

E.g. On 5V rail actual voltage = 4.85V
ADC reading = 11000101 0b = C5 hex
PICO Voltage measurement = (ADC reading) * (bit resolution)
= C5 hex * (0.0245) = 4.8265V

| VOLTAGE SCALING FACTORS | | | | |
|---|---|---|---|---|
| | Hurricane | Boxstore | Hurricane | Boxstore |
| Power Rail | Resolution | Resister Value | Resolution | Resister Value |
| 3.3 Volt | 19.5mV/bit | 40C3h | 19.5mV/bit | 40C3h |
| 5 Volt | 25.4mV/bit | 40F5h | 25.4mV/bit | 40F5h |
| 12 Volt | 58.6mV/bit | 24A4h | 58.6mV/bit | 24A4h |

Note: The register values for scaling factors in this table have been generated based on the Eurologic 2-byte Floating Point Format as defined in section 7.3.2.

### 4.2.2 Current Measurements

PICO will be required to monitor the current on the 3.3V, 5V and 12V power rails in the PSU. The current will be calculated using the scaling values supplied by the PSU manufacturer for the translating the voltage level to a current value. The 3.3V, 5V and 12V rails will be divided down to a range between AGND and AVCC so they can be measure by the ADC.

For Hurricane, the maximum current capable of measured on the 3.3V line will be 0.3A, so the bit resolution will be 1.17mA. The maximum current capable of measured on the 5V line will be 35A, so the bit resolution will be 136.7mA. The maximum current capable of measured on the 12V line will be 50A, so the bit resolution will be 195mA.
The current levels per bit are shown on the table below.

| Bit No. / Voltage Level | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|---|
| [illegible] | 0.14976 | 0.07488 | 0.03744 | 0.01872 | 0.00936 | 0.00468 | 0.00234 | 0.00117 |
| 5v | 17.4976 | 8.7488 | 4.3744 | 2.1872 | 1.0936 | 0.5468 | 0.2734 | 0.1367 |
| 12v | 24.96 | 12.48 | 6.24 | 3.12 | 1.56 | 0.78 | 0.39 | 0.195 |

E.g. On 5V rail actual voltage = 27A
ADC reading = 11000101 0b = C5 hex
PICO Current measurement = (ADC reading) * (bit resolution)
= C5 hex * (0.1367) = 26.9299A

| CURRENT SCALING FACTORS | | | | |
|---|---|---|---|---|
| | Hurricane | Boxstore | Hurricane | Boxstore |
| Power Rail | Resolution | Resister Value | Resolution | Resister Value |
| 3.3V Current | 1.17mA/bit | 5075h | 48.8mA/bit | 41E8h |
| 5V Current | 136.7mA/bit | 4557h | 214.8mA/bit | 4864h |
| 12V Current | 195mA/bit | 30C3h | 170.8mA/bit | 46ADh |

Note: The register values for scaling factors in this table have been generated based on the Eurologic 2-byte Floating Point Format as defined in section 7.3.2.

## 4.3 Permanent Data Storage

There is a requirement for 34 bytes of permanent data storage on the PICO board. The information that these bytes will contain will include the serial number, part number, and the scaling factors for voltage and current conversion. This information will be stored in the flash code space of the PICO microcontroller at a fixed address.
The design will allow us to introduce a microcontroller mask part at a later stage if the code settles down and we wish to cost reduce the design. This mask part will not have the ability to change permanent data in manufacturing, so to allow this we will include and EEPROM in the design and not stuff it in the initial manufactured product with the flash microcontroller.

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### 4.3.1 Programming PSU Specific Data

The task involved in programming the PSU serial number, part number and revision is straightforward but needs to documented as an item to be completed for signoff of PICO to production. The steps involved are:

1. Compile the PICO code which will include the firmware revision and the predefined scaling value for the voltage and current calculations generating a hex or binary file for download. This will be under the control of R&D and released to operations using the NPI and ECO processes.
2. Generate the PSU serial number, part number and version number. These will be generated by operations for every PSU.
3. Run program to integrate the PSU serial number, part number and version number in to the hex or binary file for download. This will be done by operations for every PSU.
4. Run the download utility to program the PICO microcontroller. This will be done by operations for every PSU.

*Note: Input from power supply manufacturer and Eurologic manufacturing will be required. Any software required can be written by Eurologic.*

## 4.4 Temporary Data Storage

All temporary data on the microcontroller will be held in SRAM or general purpose working registers. This data will consist of the data shown in table 4.6.1 below. The first byte will be read/write data the others will be read only. If more data bytes are requested than are supported the microcontroller will output FF hex after the last valid data byte. If more data bytes are written than the single byte supported then the extra bytes received will be ignored.

The voltage and current values reported will each be an 8 bit (1 byte) value read from the ADC. If there is a requirement to do some calculations on this data it will be carried out in the VIXEN microcontroller using the scaling factor associated with the analog signal being measured.

## 4.5 General Purpose I/O (GPIO)

There will be a requirement for a number of GPIO pins. The GPIO required and the functionality of the GPIO is described in table 4.5.

| Name | Type | Purpose |
|---|---|---|
| SMB_A0, SMB_A1 | 2 digital inputs | These are used to configure the 2 wire serial address for the microcontroller |
| Yellow LED | 1 digital LED output | Used to control the Fault LED |
| 3.3V, 5V, 12V Monitor IC<br>3.3V, 5V, 12, Imonitor IC | 6 analog to digital converter (ADC) inputs | These are used to measure the current and the voltages on the 3.3, 5 and 12 volt lines |
| AC FAIL S | 1 digital interrupt pin | Used to detect AC fail conditions |
| SMB_SCL, SMB_SDA | 2 dedicated digital I/O lines with serial hardware | Used for the 2 wire serial bus interface |
| Temp Fail | 1 digital input/interrupt | Used to detect a PSU temperature failure |
| 3.3V, 5V, 12V Fail<br>3.3V, 5V, 12, IFail | 6 digital inputs | Used to detect current and voltage failure on the 3.3, 5, and 12 v lines |
| Vref | 1 analog reference voltage | Used to determine the voltages and currents measured on the ADC. |
| SMB_SCL_MSK, SMB_SDA_MSK | 2 digital I/O lines | For future development and cost reduction. Used to talk to an eeprom if a Mask part is used. The eeprom will store the part No. serial No. and the PSU revision |

Table 4.5

## 4.6 Serial Communication

### 4.6.1 Vixen Two Wire Serial Bus

PICO serial communications will be carried out using the standard Eurologic 2 wire serial bus. This bus will be used by VIXEN to access PICO. PICO will support the serial slave mode only, it will be capable of receiving one byte of data and transmitting 1 to 56 bytes of data.



The po[illegible]le 56 bytes of data are shown in table 4.6.1.

When writing to PICO the first byte will be a command byte and the subsequent bytes will be data that will be operated upon. A number of commands will be supported in future releases but the first release will only support the command byte 01 (hex). This command will be followed by one byte and that byte will be the summary byte.

When reading from PICO all 56 bytes can be read in the order shown. If more bytes are written than are allowed then only the first byte shall be treated as valid and the excess bytes will be ignored. If more than the maximum number of bytes available are being read then all extra bytes transmitted will be set to FF hex.

If we move to a Mask microcontroller part the data specific to the PSU and setup during manufacturing will be stored in the EEPROM and loaded via ICT or another two wire serial master. Also at this stage new commands will be added to allow us to allow us to program the resolution factors, part number, and serial number over the serial management bus.

| Byte | Direction | Name | Description |
|---|---|---|---|
| Byte 0 | R/W | PSU Summary 0 | Power Supply Summary 0 |
| Byte 1 | R/W | PSU Summary 1 | Power Supply Summary 1 |
| Byte 2 | R | PSU Status 0 | Power Supply Status 0 |
| Byte 3 | R | Reserved | Reserved |
| Byte 4 | R | 3.3 Voltage Reading | Actual voltage on the 3.3V line |
| Byte 5 | R | 3.3 Current Reading | Actual current on the 3.3V line |
| Byte 6 | R | 5 Voltage Reading | Actual voltage on the 5V line |
| Byte 7 | R | 5 Current Reading | Actual current on the 5V line |
| Byte 8 | R | 12 Voltage Reading | Actual voltage on the 12V line |
| Byte 9 | R | 12 Current Reading | Actual current on the 12V line |
| Byte 10,11** | R | 3.3V Resolution | 3.3V Resolution (19.5mV) |
| Byte 12,13** | R | 3.3A Resolution | 5V Resolution (24.5mV) |
| Byte 14,15** | R | 5V Resolution | 12V Resolution (58.6mV) |
| Byte 16,17** | R | 5A Resolution | 3.3V current Resolution (1.17mA) |
| Byte 18,19** | R | 12V Resolution | 5V current Resolution (136.7mA) |
| Byte 20,21** | R | 12A Resolution | 12V current Resolution (195mA) |
| Byte 22** … Byte 37 | R | PSU Part Number | PSU part number also on label of PSU |
| Byte 38** … Byte 54 | R | PSU Serial Number | PSU serial number also on bar code label |
| Byte 55 Byte 56 | R | Build Number | A number directly related to the revision of the firmware. |

* Permanent data from Firmware build
** Permanent data stored in Flash from manufacturing

Table 4.6.1

### 4.6.2 PICO EEPROM Two Wire Serial Bus

If the EEPROM is connected to the microcontroller it will use an independent 2 wire serial bus, the permanent data will be reported as shown in table 4.6.1 above. The permanent data will not be stored in the microcontroller, the microcontroller in this case will be a mask part.

## 5 Register Definitions

### 5.1 PSU Summary

This register contains summary information on the current status of the PSU; it should be possible to confirm correct operation by a single read of this register. The following bits are defined in Table 5.1.

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| | Led Status and Request | | Auto | AC Fail Latched | AC Fail | PSU shutdown | Summary |
| Reserved | Reserved | Reserved | Reserved | Reserved | Power Up Ack | Temp Fail Latched | Temp Fail |

Table 5.1

#### 5.1.1 Summary

Set to a 1 when a fault is detected in the PSU. Set to a 0 if the power supply is operating normally. Writing to this bit has no effect.

#### 5.1.2 PSU Off

Set to a 1 when the power supply is off or non-operational, 0 Otherwise. The power supply hardware reports this state to the microcontroller via the shutdown signal. Writing to this bit has no effect. When the shutdown signal causes an interrupt the PSU will cease to operate and will require a power reset to recover. PICO will record all the digital inputs when this situation occurs and PICO will stop recording new values on the ADC channels. When accessed PICO will only report these latched values. After power cycling PICO will return to normal operation.

#### 5.1.3 AC Fail

Set to a 1 when the AC input voltage is below 75VAC +/- TBD, 0 otherwise. Writing to this bit has no effect.

#### 5.1.4 AC Fail Latched

Set to 1 if an AC_FAIL has been detected and recovered, it will be recorded using an edge triggered interrupt. A 1 must be written to this bit to set it back to 0. When the AC fail interrupt is detected and recovered the microcontroller will set this bit to a 1. This bit can only be reset by VIXEN, writing a '1' will clear this bit. This will record any AC fail until VIXEN has seen it and requests that it be cleared.

#### 5.1.5 Auto

Set to a 0 when the PSU monitoring is working in autonomous mode, otherwise set to 1 by VIXEN. PICO will by default have this bit cleared, this will allow it to report the PSU status to the user via the LED. If VIXEN sets this bit PICO will not report the PSU status

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via the LED, the status will be under the control of VIXEN. Once the PSU is under control of VIXEN the only way to reset it to autonomous is to reset PICO or write the Auto bit back to 0.

### 5.1.6 LED Status and Request

The LED will flash on and off at different rate depending on the pattern set in these 3 bits. The flash rates are defined in table 5.1.6 below.

| Priority | LED Pattern | Description |
|---|---|---|
| 0x00 | 0x0000 | LED permanently off |
| 0x01 | 0xaaaa | LED on for 125mS LED off for 125 mS – repeat forever |
| 0x02 | 0x3333 | LED on for 250mS LED off for 250 mS – repeat forever |
| 0x03 | 0x1111 | LED on for 125mS LED off for 375 mS – repeat forever |
| 0x04 | 0xeeee | LED on for 375mS LED off for 125 mS – repeat forever |
| 0x05 | 0x00ff | LED on for 1000mS LED off for 1000 mS – repeat forever |
| 0x06 | 0x0f0f | LED on for 500mS LED off for 500 mS – repeat forever |
| 0x07 | 0xffff | LED permanently on |

Table 5.1.6

*Note: The general fault state will be used to indicate one or more problems in a PSU.*

### 5.1.7 Temp Fail

Set to 1 if the power supply is in an over temperature condition, 0 otherwise

### 5.1.8 Temp Fail Latched

Set to 1 if a Temp fail has been detected and gone away, it will be recorded using an edge triggered interrupt. A 1 must be written to this bit to set it back to 0. When the Temp fail interrupt detects the temperature fault going away the microcontroller will set this bit to a 1. This bit can only be reset by VIXEN, writing a 1 will clear this bit. This will record any Temp fail until VIXEN has seen it and requests that it be cleared.

### 5.1.9 Power Up Ack

This bit will be set to '1' every time PICO is powered up. Writing a '1' to this location will clear this bit.

## 5.2 PSU Status

This register contains information on the current status of the PSU read from 6 inputs supplied by the PSU vendor. These signals will show a failure when the power supply has gone outside the Eurologic defined parameters defined in Ref. / 2 /. The following bits in this register are defined as shown below, all those marked reserved return zero when read. All writes to this register are ignored.

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Reserved | Reserved | 12A Fail | 12v Fail | 5A Fail | 5v Fail | 3.3A Fail | 3.3v Fail |

Table 5.2

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*Note: All the calculations for determining that a voltage and current is outside predetermined limits will be carried out by the PSU hardware.*

### 5.2.1 3.3V Fail

Set to 1 if the 3.3V output voltage is outside predetermined limits, 0 otherwise.

### 5.2.2 3.3A Fail

Set to 1 if the 3.3V output current is outside predetermined limits, 0 otherwise

### 5.2.3 5V Fail

Set to 1 if the 5V output voltage is outside predetermined limits, 0 otherwise

### 5.2.4 5A Fail

Set to 1 if the 5V output current is outside predetermined limits, 0 otherwise

### 5.2.5 12V Fail

Set to 1 if the 12V output voltage is outside predetermined limits, 0 otherwise

### 5.2.6 12A Fail

Set to 1 if the 12V output current is outside predetermined limits, 0 otherwise

## 5.3 3.3 Voltage Reading

When this register is read it returns the analog voltage measured on the 3.3V output. The analog voltage range of the ADC is from 0 to 5 volts and the resolution is in steps of 19.5mV/bit. Writes to this register are ignored. The voltage range will be from 00 to FF hex where FF hex will be full scale of the ADC, i.e. the maximum measurable voltage.

VIXEN should use the following method to calculate the voltage read by PICO.
(3.3v measurement) * (Resolution)
For example if 7F hex is read in from PICO in the PSU 3.3V Register
7F hex = 124 decimal => (124)*(0.0195) = 2.418V.

## 5.4 3.3 Current Reading

The PSU 3.3A register returns the analog current sourced from the 3.3V output. The analog current range is from 0A to .3A and the resolution of the ADC is in steps of 1.17mA/bit. Writes to this register are ignored. This voltage will have to be scaled in order to calculate the associated current. The associated scaling factor is TBD. The current range will be from 00 to FF hex where FF hex will be full scale of the ADC, i.e. the maximum measurable current.

VIXEN should use the following method to calculate the voltage read by PICO.
(3.3A measurement) * (Resolution)

For example if 7F hex is read in from PICO in the PSU 3.3A Register
7F hex = 124 decimal => (124)*(0.00117) = 0.14508A.

## 5.5 5 Voltage Reading

When this register is read it returns the analog voltage measured on the 5V output. The analog voltage of the ADC range is from 0 to 6.5 volts and the resolution is in steps of 25.4mV/bit. Writes to this register are ignored. The voltage range will be from 00h to FF hex where FF hex will be full scale of the ADC, i.e. the maximum measurable voltage.

VIXEN should use the following method to calculate the voltage read by PICO.
(5V measurement) * (Resolution)
For example if 7F hex is read in from PICO in the PSU 5v Register
7F hex = 124decimal => (124)*(0.0254) = 3.1496V.

## 5.6 5 Current Reading

The PSU 5A register returns the analog current sourced from the 5V output. The analog current range is from 0A to 35A and the resolution of the ADC is in steps of 136.7mA/bit. Writes to this register are ignored. The current range will be from 00 to FF hex where FF hex will be full scale of the ADC, i.e. the maximum measurable current.

VIXEN should use the following method to calculate the voltage read by PICO.
(5A measurement) * (Resolution)
For example if 7F hex is read in from PICO in the PSU 5A Register
7F hex = 124 decimal => (124)*(0.1367) = 16.9508A.

## 5.7 12 Voltage Reading

When this register is read it returns the analog voltage measured on the 12V output. The analog voltage range of the ADC is from 0 to 15 volts and the resolution is in steps of 058.6mV/bit. Writes to this register are ignored. The voltage range will be from 00 to FF hex, where FF hex will be full scale of the ADC, i.e. the maximum measurable voltage.

VIXEN should use the following method to calculate the voltage read by PICO.
(5V measurement) * (Resolution)
For example if 7F hex is read in from PICO in the PSU 12v Register
7F hex = 124 decimal => (124)*(0.0586) = 7.2664V.

## 5.8 12 Current Reading

The PSU 12A register returns the analog current sourced from the 12V output. The analog current range is from 0A to 50A and the resolution of the ADC is in steps of 195mA/bit. Writes to this register are ignored. The current range will be from 00 to FF hex where FF hex will be full scale of the ADC, i.e. the maximum measurable current.

VIXEN should use the following method to calculate the voltage read by PICO.
(5A measurement) * (Resolution)
For example if 7F hex is read in from PICO in the PSU 12A Register
7F hex = 124 decimal => (124)*(0.195) = 24.18A.

## 5.9 3.3V Resolution

This value is used by VIXEN to calculate the actual voltage measured on the 3.3V line by PICO. This value is fixed in the firmware and built in to the code at compile time. This value will be set to 19.5mV/bit. Data written to this location is ignored.
The resolution will be stored in two bytes in a Eurologic defined floating point method, this is described in section 7.3.

## 5.10 3.3A Resolution

This value is used by VIXEN to calculate the actual current measured on the 3.3V line by PICO. This value is fixed in the firmware and built in to the code at compile time. This value is 1.17mA. Data written to this location is ignored.
The resolution will be stored in two bytes in a Eurologic defined floating point method, this is described in section 7.3.

## 5.11 5V Resolution

This value is used by VIXEN to calculate the actual voltage measured on the 5V line by PICO. This value is fixed in the firmware and built in to the code at compile time. This value is 24.5mV. Data written to this location is ignored.
The resolution will be stored in two bytes in a Eurologic defined floating point method, this is described in section 7.3.

## 5.12 5A Resolution

This value is used by VIXEN to calculate the actual current measured on the 5V line by PICO. This value is fixed in the firmware and built in to the code at compile time. This value is 136.7mA. Data written to this location is ignored.
The resolution will be stored in two bytes in a Eurologic defined floating point method, this is described in section 7.3.

## 5.13 12V Resolution

This value is used by VIXEN to calculate the actual voltage measured on the 12V line by PICO. This value is fixed in the firmware and built in to the code at compile time. This value will be set to 58.6mV. Data written to this location is ignored.
The resolution will be stored in two bytes in a Eurologic defined floating point method, this is described in section 7.3.

## 5.14 12A Resolution

This value is used by VIXEN to calculate the actual current measured on the 12V line by PICO. This value is fixed in the firmware and built in to the code at compile time. This value is 195mA. Data written to this location is ignored.
The resolution will be stored in two bytes in a Eurologic defined floating point method, this is described in section 7.3.

## 5.15 PSU Part Number

This data is permanent and programmed in production. When these registers are read they return the PSU part number as a string of up to 16 hexadecimal characters. The part

number will made up of the firmware revision, the hardware revision, the system type and the hardware vendor. The string will match the part number printed on the PSU label. Data written to this register is ignored.

| Byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Reserved | | | | | | Hardware Vendor | System | HM | | hm | | FM | | fm | |

Hardware Vendor – This byte will be used to define the manufacturer of the power supply. This byte will be an ASCII byte and will be valid from '0' to '9'.

| BYTE 0 | Hardware Vendor |
|---|---|
| 0 | Artesyn |
| 1 | Celestica |
| 2 … F | Reserved |

System – These two bytes will be used to define the system that the power supply is to be used in. This byte will be an ASCII byte and will be valid from '0' to '9'.

| BYTE 0 | System |
|---|---|
| 0 | Hurricane |
| 1 | Boxster |
| 2 | Porche |
| 3 … F | Reserved |

HM – This is the Major hardware revision level valid from 00 to 99 ASCII.
hm – This is the Minor hardware revision level valid from 00 to 99 ASCII.
FM – This is the Major hardware revision level valid from 00 to 99 ASCII.
fm – This is the Major hardware revision level valid from 00 to 99 ASCII.

### 5.16 PSU Serial Number

This data is permanent and programmed in production. When these registers are read they return the PSU serial number as a string of up to 16 ASCII characters. The serial number string should match the serial number printed on the PSU label and is the responsibility of operations. Data written to this register is ignored.

### 5.17 Build Number

This number is a two byte hexadecimal value that will start at 0x0001 and be incremented everytime a new release of PICO firmware issued. This number is not a revision number but using this number and the firmware source code database one will be able to build any revision of PICO firmware.

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## 6 Reading and Writing Data

### 6.1 Reading

When reading data from PICO, address PICO at the correct serial address, the valid addresses will be from 20 hex to 23 hex. Then set the serial read/write bit in the address byte to read, the PICO device will then stretch the clock until it has processed the received interrupts and setup the data to transmit. The VIXEN board will then toggle the clock 9 times (8 bits of data and 1 acknowledge) for each byte it wants to receive from PICO. The PICO data will be transmitted starting with byte 0 followed by byte 1 and continue until VIXEN stops the transfer. If the number of bytes being clocked out exceeds the page length the byte 0xBC hex will be transmitted.

### 6.2 Writing

The data that is written to PICO should be limited to 17 bytes, the first byte will be a command byte and the next 16 will be the data or payload. The commands that PICO will support are listed in the table below with a data length and description.

| Command | Command Byte | Data Length | Data Description |
|---|---|---|---|
| Status | 0x01 | 2 bytes | Status Data to be implemented by PICO |
| Error Priority | 0x02 | 11 bytes | The error led information for each error in PICO *Note 1* |
| Led Pattern | 0x03 | 8 integers (16 bytes) | The pattern that each led priority is allocated *Note 1* |
| Scaling Factor | 0x04 | 8 integers (16 bytes) | The scaling factor associated with each analog measurement. *Note 1* |
| Part Number | 0x05 | 16 bytes | The PICO board part number *Note 1* |
| Serial Number | 0x06 | 16 bytes | The PICO board serial Number *Note 1* |
| Reboot | 0xbb | 0 bytes | This will cause PICO to restart |

*Note 1 – In the first release of PICO this information will be received and stored in RAM, so everytime PICO is reset this information will have to be updated. At a later stage when we add an EEPROM to the system this information will be written out to the EEPROM and stored permanently.*

#### 6.2.1 Status Command

This command will be followed by 2 bytes of information, all other bytes will be ignored. The information in these byte will be as shown in the table below and valid as described bythe PSU Summary in section 5.2 of this document.

| Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|---|
| Led Status and Request | | | Enable Auto Mode | Reset AC Fail Latched | Reserved | Reserved | Reserved |
| Reserved | Reserved | Reserved | Reserved | Reserved | Power Up | Temp Fail | Reserved |

### 6.2.2 Error Priority

The PICO board supports 11 possible errors, each of these is assigned a priority. The possible priorities are from 0 to 7 with 0 being the lowest. By default all errors are assigned a priority of 7. This priority is used to select a LED pattern to be displayed when the error occurs. If 2 errors are detected in the system the error with the highest priority will be used to select the led pattern to displayed. The table below shows the possible errors and the order that the data should be presented to PICO.

| Failure | Default Priority |
|---|---|
| AC fail | 0x07 |
| Temp fail | 0x07 |
| 3.3V fail | 0x07 |
| 5V fail | 0x07 |
| 12V fail | 0x07 |
| 3.3I fail | 0x07 |
| 5I fail | 0x07 |
| 12I fail | 0x07 |
| PSU Shutdown | 0x07 |
| AC fail latch | 0x07 |
| Temp fail latch | 0x07 |

### 6.2.3 Led Pattern

PICO will support 8 possible LED Patterns, these are directly related to the priority of an error. The table below shows the LED patterns assigned to each of the priorities. Each bit of the 16 bit pattern is assigned a 125mS time interval. If the bit position is a '1' the LED is switched on for 125mS and if the bit is '0' the LED is switched off for 125mS. So using the table below 0x00 hex = 0x0000 hex will force the LED to be off all the time and 0x07 hex = 0xffff hex will force the LED to be on all the time.

| Priority | LED Pattern | Description |
|---|---|---|
| 0x00 | 0x0000 | LED permanently off |
| 0x01 | 0xaaaa | LED on for 125mS LED off for 125 mS – repeat forever |
| 0x02 | 0x3333 | LED on for 250mS LED off for 250 mS – repeat forever |
| 0x03 | 0x1111 | LED on for 125mS LED off for 375 mS – repeat forever |
| 0x04 | 0xeeee | LED on for 375mS LED off for 125 mS – repeat forever |
| 0x05 | 0x00ff | LED on for 1000mS LED off for 1000 mS – repeat forever |
| 0x06 | 0x0f0f | LED on for 500mS LED off for 500 mS – repeat forever |
| 0x07 | 0xffff | LED permanently on |

### 6.2.4 Scaling Factor

PICO supports 6 analog readings, each of which have an associated scaling value. The ADC on PICO only measures from 0 to 5 volts so the analog signals must be scaled to represent the true value in the power supply. These values are fixed based on the engin[illegible] spec for each power supply. The values also take the format as described in section 7.3. The order that PICO expects to receive this data is shown below.

| |
|---|
| Resolution for 3.3V |
| Resolution for 5 |
| Resolution for 12V |
| Resolution for 3.3I |
| Resolution for 5I |
| Resolution for 12I |

### 6.2.5 Part Number

The part number for PICO will be 16 bytes long and the format used will be as defined in section 5.15.

### 6.2.6 Serial Number

The serial number for PICO will be 16 bytes long and the format used will be as defined in section 5.16.

### 6.2.7 Reboot

This command will cause PICO to restart from the beginning of the code. This reboot will appear to the user and to VIXEN as a power on reset of PICO. The PSU power up bit will be set after this command is executed, any data in RAM will be lost after this command is executed.

## 7 Software

### 7.1 Naming Conventions

Where possible the firmware group coding guidelines Ref. / 1 / will be used.

#### 7.1.1 Firmware Modules used

The firmware will be made up of a number of code modules. These code modules will be stored in a directory structure in accordance with Ref / 1 /. This will made as efficient as possible and will be run from the Flash code space on the microcontroller.

All the code will written in 'C', with some exceptions for bootstrap code and possibly some low-level or speed critical routines. Any application notes supplied by the microcontroller vendor will be converted, where possible, to the Eurologic style and documented thoroughly.

The only limitation on the code is that it must not use clock stretching when being read by VIXEN. This will require PICO to handle the reception and transmission of data in the interrupt service routine for 2 wire serial communications.

## 7.2 Structure

This will be detailed in the firmware design specification.

## 7.3 Floating Point Number Storage

### 7.3.1 4-byte Floating Point Format

The NEC microcontroller represents floating point value by a 4 byte number in standard IEEE format. The memory of a 4 byte floating point number is:

| 31 30 | 30 24 | 23 0 |
|---|---|---|
| S | Exponent | Mantissa |

This format is very long for the Eurologic application as there is a requirement to store 6 floating point values. Also the NEC processor will not have to carry out any mathematical operations on these numbers, so the structure need not be in a standard format. For these reason Eurologic have decided to create their own floating point format.

### 7.3.2 Eurologic 2-byte Floating Point Format

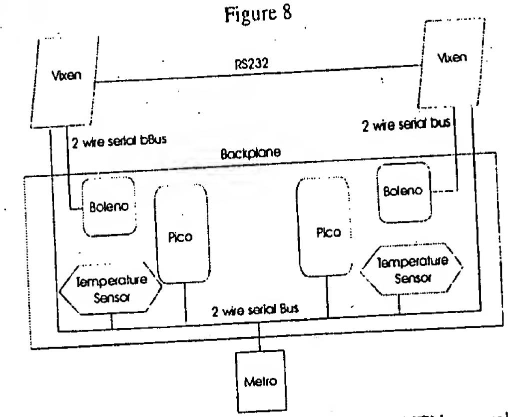
The 16 bits are divide into two bit sections, 12 bits and 4 bits. The first 12 bits will represent a number in hex format while the 4 bits will represent the exponent value time minus 1. This is shown in a diagram below and a few examples are shown. The range of this notation is from 4095 (0FFF hex) to $4.095*10^{-19}$ (FFFF hex).

| 15 12 | 11 0 |
|---|---|
| Mantissa | Exponent |

e.g.
19.5mV = (decimal) $195*10^{-4}$ = (hex) $C3*10^{-4}$ = 40C3 hex
1.17mA = (decimal) $117*10^{-5}$ = (hex) $75*10^{-5}$ = 5075 hex

## 8 Typical Hardware Layout

Figure 8




As can be seen in Figure 8 PICO will be connected to the VIXEN general-purpose 2 wire serial bus, along with Metro and the temperature sensors.

### 8.1 Two Wire Serial Bus Address

PICO will support four serial bus addresses. These addresses will be from 20 hex to 23 hex inclusive. The address will be read in from two pins connected to the backplane. These pins cause the address to be different based on the position of the power supply in the system, e.g. left = 20 hex and right = 21 hex.

The temperature sensors on the PICO board will have addresses from 4C hex to 4F hex inclusive. The temperature sensors addresses will be 010011XXb where XX are the same as the 2 least significant bits in the PSU serial address:

I.e. PSU = 20 hex Temperature Sensor = 4C hex
and PSU = 22 hex Temperature Sensor = 4E hex.

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